

# PHYSIOLOGICAL ISOLATION OF TYPES IN THE GENUS *XANTHIUM*

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(WITH SEVEN FIGURES)

While collecting *Xanthium* seeds for physiological studies, my attention has often been called to the heterogeneity of the *Xanthium* population in the field. Burs collected from several widely separated localities belong to the uncertain group listed under the name of *X. canadense* Miller in ROBINSON and FERNALD's seventh edition of GRAY's *Manual*.

In the annual report of the botanist of the Department of Agriculture for 1886, VASEY mentions *X. canadense* as the species troublesome in the west, while the principal eastern species is called *X. strumarium*. But it is now known that *X. strumarium* has never been introduced into America. As several types were often found growing intermingled in Kansas and Kentucky, the possibility of hybridization suggested itself.

Desiring seeds of uniform physiological character for certain investigations in which great accuracy was necessary, I collected burs from the three main types occurring in the fields about Lawrence, Kansas. In each case the seeds were chosen from a single plant of the type. It was thought that the various forms were possibly the result of promiscuous crossing of varieties or elementary species, and that a year or two of guarded pollination would be necessary to purify the strains so that physiological properties as well as morphological characters might be uniform. The use of pure bred material for physiological investigations has not yet been considered essential, but it may be very desirable, or even necessary, for certain kinds of work. Burs from the three types chosen are shown in figs. 1, 2, and 3. The original plants stood side by side on the northern edge of the Wakarusa floodplain about 0.5 kilometer south of Mount Oread. After being photographed, the burs were opened, and the seeds of the three types were found



to differ (fig. 4). The type with globose burs has much shorter seeds than the other two types, which are evidently more closely related. The seeds from type I have a dark brown testa, while those of type II have a dull greenish or grayish brown testa, and type III a yellowish brown testa.

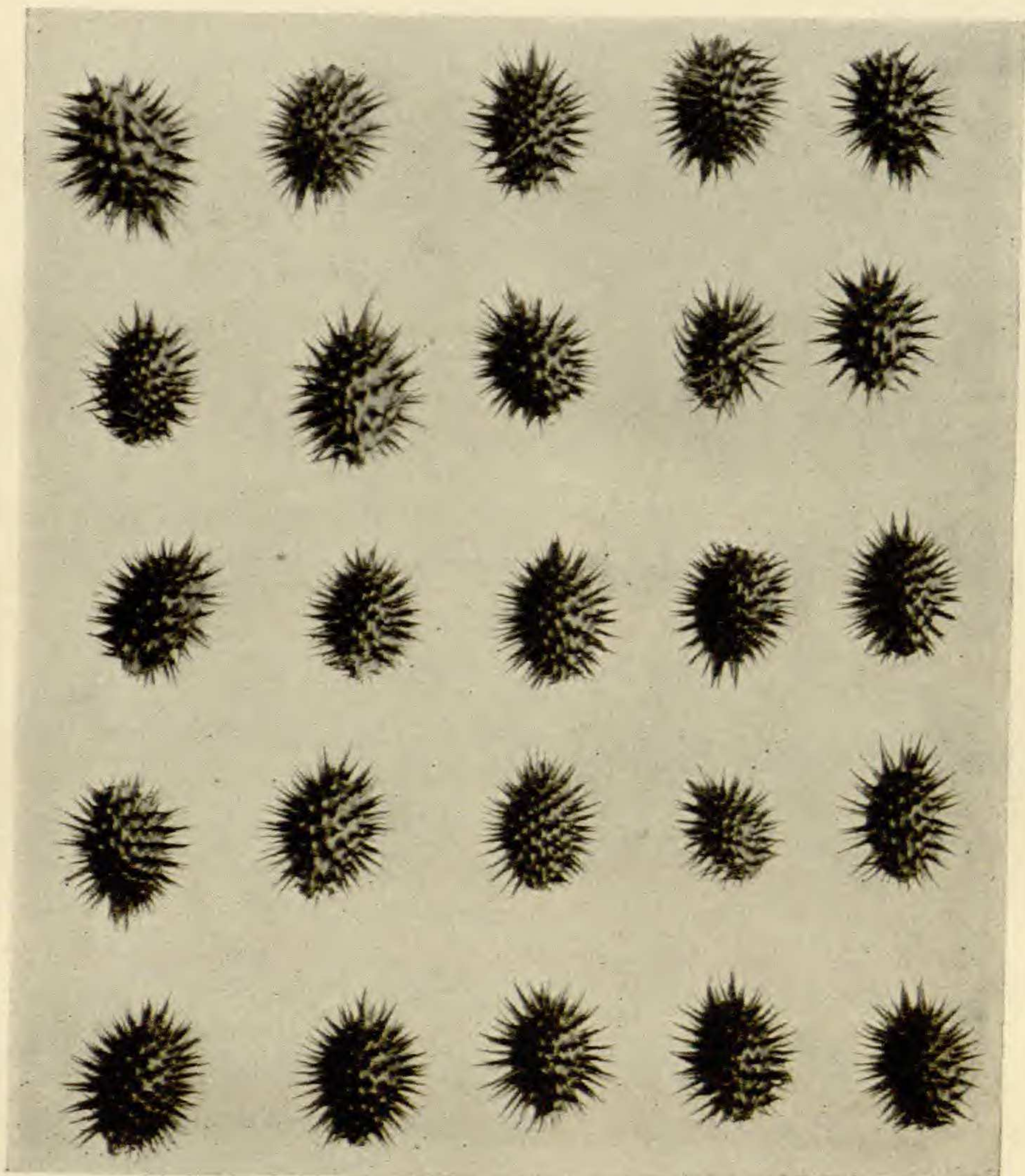


FIG. 1.—Type I, *Xanthium globosum* Shull, sp. nov.; natural size

The variation in size and weight of the seeds of the several types is under investigation. The average weight of 50 upper seeds of type I in the crop of 1913, an excessively dry year, is about 20 mg., of the lowers 27 mg. The corresponding average weights for type II are 28 mg. and 48 mg. respectively. The curves of variability in weight and length will probably show some overlapping in the



two types when a larger series has been measured, but it is certain to be slight.

Seedlings raised in the laboratory were transferred to the breeding grounds about June 1, 1913. Typical seedlings of types I and II are shown in fig. 5. The cotyledons of type I are somewhat

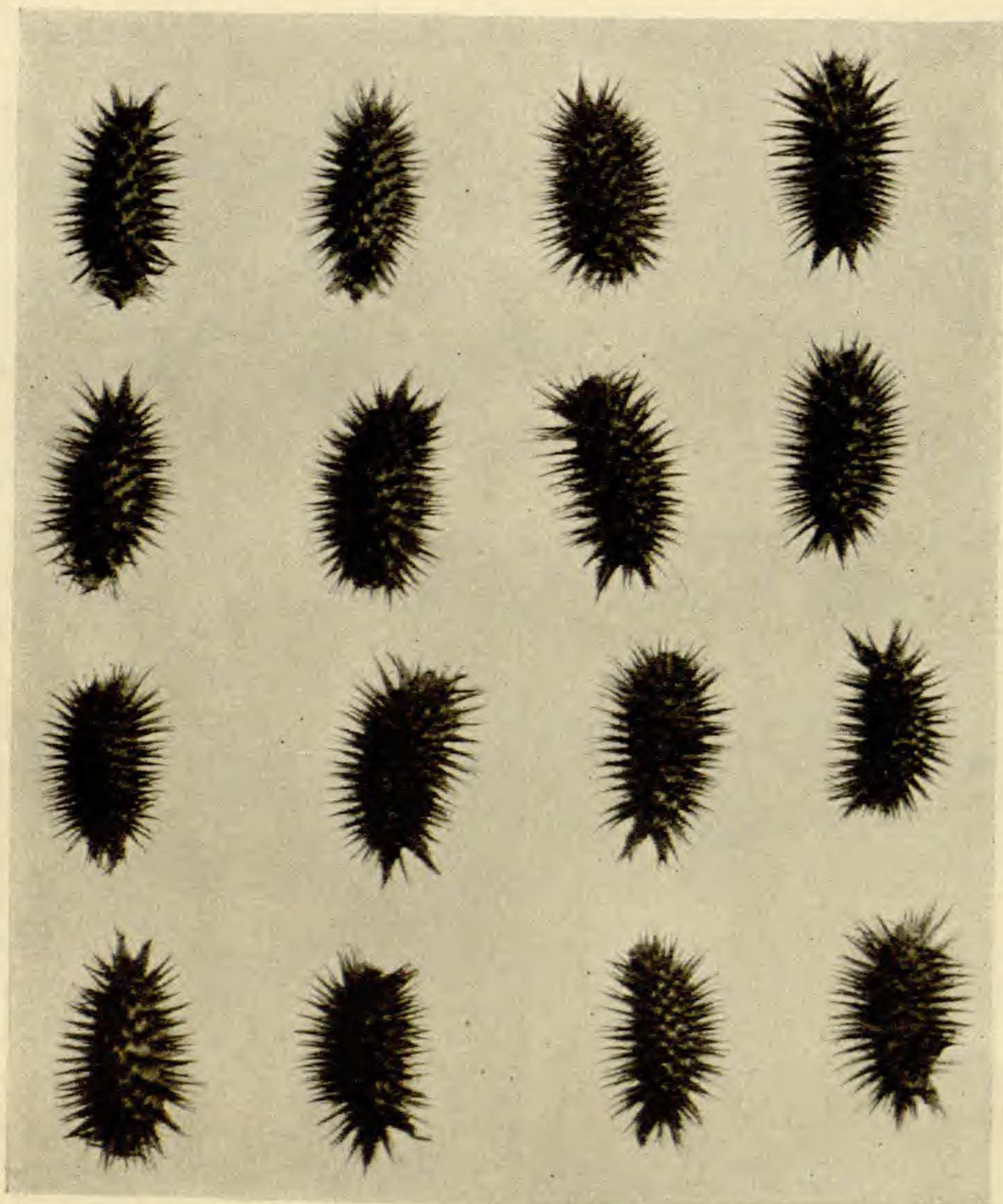


FIG. 2.—Type II, *Xanthium pennsylvanicum* Wallr.; natural size

shorter and broader than those of type II, which are long and strap-shaped; but the difference is not as great as would have been expected from the difference in the seeds.

The three types were planted within a day of each other; type I first, type II the following day, and type III last. As the plants



began to develop their characteristic mature leaves, a very surprising uniformity of the plants belonging to each type was observed. This result was wholly unexpected, as it was believed that hybridization could hardly have been avoided in nature. Type I has a dark green mesophyll with veins almost white, and a much

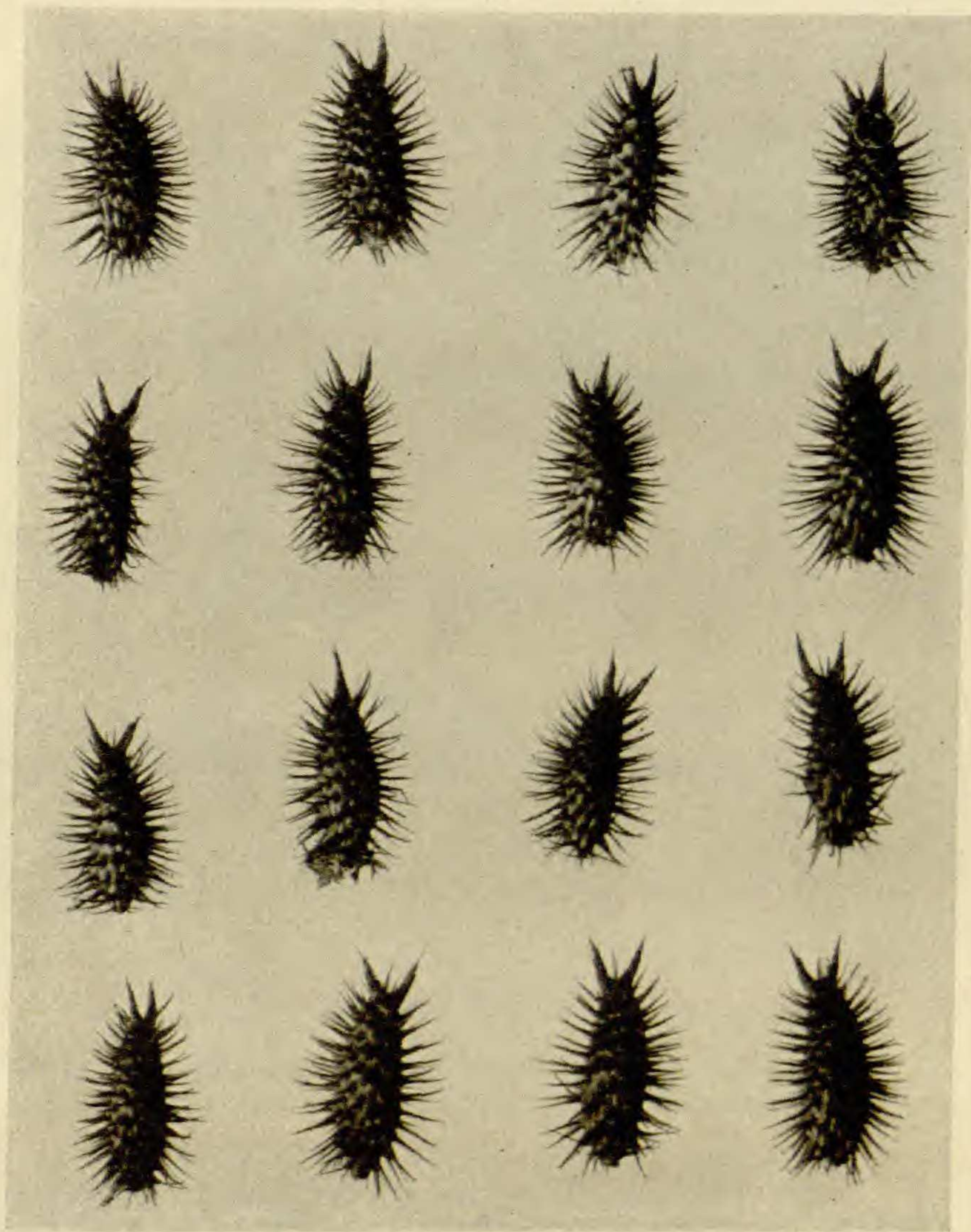


FIG. 3.—Type III, *Xanthium canadense* Mill.; natural size

crinkled surface; while type II has yellow green foliage, the leaf surfaces relatively plane. The foliage of type III resembles that of type I very closely, so that it is difficult to distinguish young plants (figs. 6 and 7 show the foliage differences of types I and II).



The most interesting difference between the two types is shown also in these figures. The photographs were taken at the same time, about September 1, 1913. Type II had shed all of its pollen and its burs were full grown. One shriveled cluster of staminate flowers can be seen above; while type I is just beginning to open its first staminate flowers, and its carpellate flowers are almost too small to be seen. Type III was intermediate, having about half

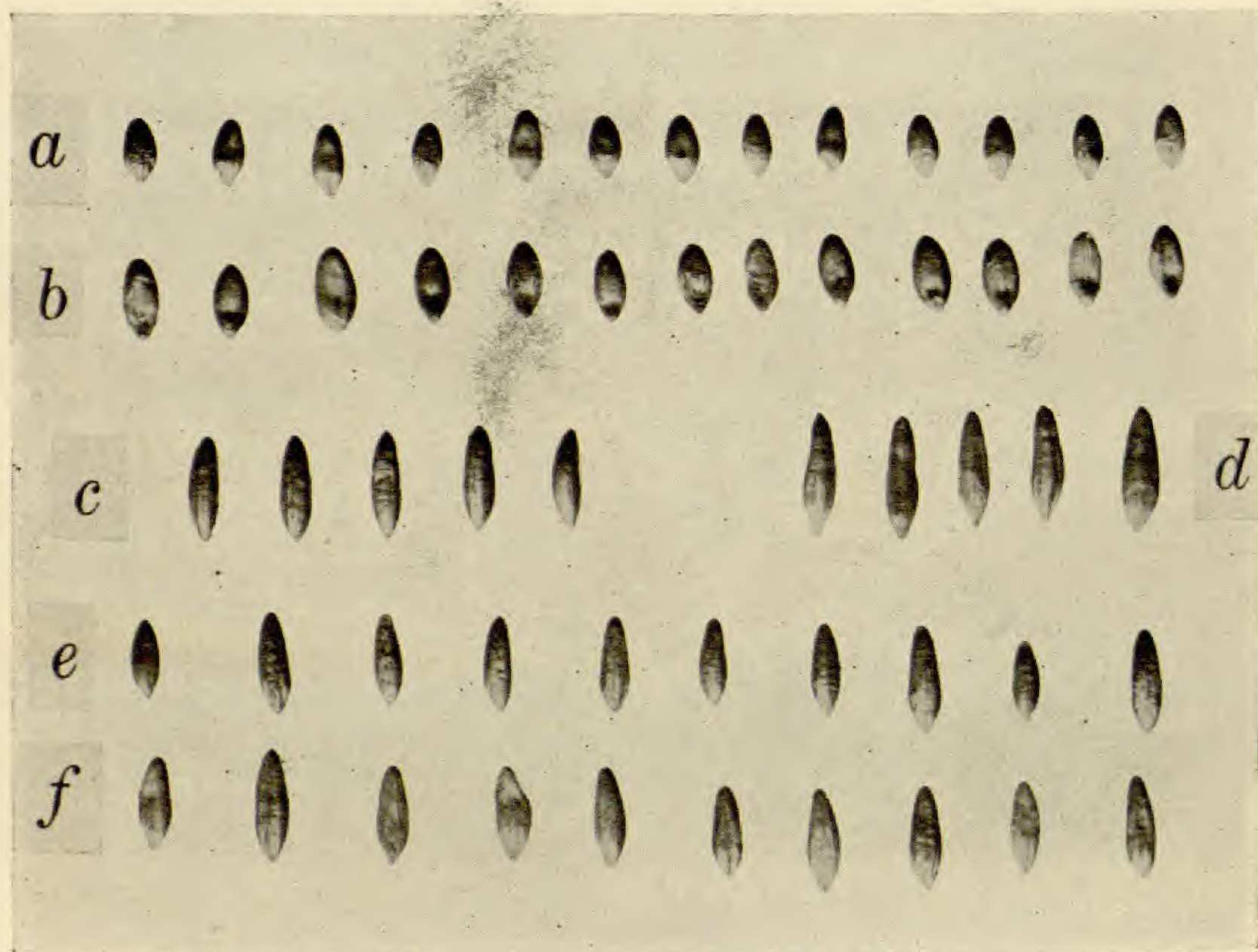


FIG. 4.—*a* and *b*, uppers and lowers of *X. globosum* Shull; *c* and *d*, uppers and lowers of *X. pennsylvanicum* Wallr.; *e* and *f*, uppers and lowers of *X. canadense* Mill.; all natural size.

grown burs at the time type I sheds its pollen; its flowers had no doubt been generally pollinated from plants of the same type. In this interesting condition we find the explanation of the remarkable uniformity exhibited by the offspring of plants taken at random from a heterogeneous population in the field. There is a physiological isolation that effectually prevents hybridization in the great majority of cases. The pollen of one variety has been shed long before the stigmas of the other are ready for the pollination processes.



During the summer of 1914, volunteer seedlings of types I and II were allowed to grow in the field under natural conditions, in competition with plants of the same types and other native weeds. The same differences in the burs and in the blooming times occurs under these circumstances, but the differences in the foliage loses some of its sharpness due to type I showing less crinkling of the mesophyll when crowded. There are wide differences



FIG. 5.—Seedlings of *Xanthium*: to the left, upper and lower of *X. pennsylvanicum* Wallr.; to the right, upper and lower of *X. globosum* Shull.

in the habit of the plants when crowded and when cultivated. The plants branch profusely when space permits, but are frequently unbranched or but slightly branched when closely crowded. Such differences will greatly alter the anatomical details of the plant structure, and tend to render such distinctions uncertain.<sup>1</sup>

One more difference between the three types remains to be noted. Type II develops considerable anthocyanin in the prickles

<sup>1</sup> The comparative anatomy of these three types of *Xanthium*, with *X. canadense* going under the name of *X. americanum*, has been described by NORA E. DALBEY (Kan. Univ. Sci. Bull. 9: 57-65. 1914).



and hairs that beset the burs, so that the rows of plants appear reddish brown long before the burs begin to dry. Type II develops much less anthocyanin, while pigment is entirely wanting in type I. When the burs have dried this difference is manifest in different shades of brown. The burs are lightest in color in type I, darkest in type II.



FIG. 6.—*X. pennsylvanicum* Wallr., at the same age as *X. globosum* Shull in fig. 7

Since the three types tend to remain distinct in the field, and since all of them show distinctive features while presenting no definite evidence of Mendelian segregation, they should be considered distinct species.

The genus *Xanthium* is in need of careful study, and possibly revision, on the basis of breeding tests. The principal difficulty in the genus from the taxonomic point of view is to interpret just what the old authors meant by *X. canadense* Mill. and *X. ameri-*



*canum* Walt. which was for a time called *X. strumarium* in the east, and which was redescribed by BRITTON in 1901 as *X. glabratum*. In the second edition of BRITTON and BROWN this species is now listed as *X. americanum* Walt. It seems clear from the descriptions that type III, with rather slender, oblong, essentially glabrous burs, should bear the name *X. canadense* Miller (Gard.



FIG. 7.—*X. globosum* Shull, at the same age as *X. pennsylvanicum* Wallr. in fig. 6

Dict. ed. 8. no. 2. 1768); with this species, *X. americanum* Walt. (1. Car. 231. 1788) and *X. glabratum* Britt. (BRITT. Manual 912. 1901) are synonymous.

Type II, with oblong pubescent fruit, agrees fairly well with the description of *X. pennsylvanicum* Wallr., and must on the basis



of breeding test be considered as a species distinct from *X. canadense* Miller.

The burs of type I do not resemble those of any of the 8 species now recognized in the territory east of the 100th meridian. This variety was first seen on the campus of the State University of Kentucky several years ago, where it formed a very small percentage of the cocklebur population. But here it was the most prominent variety in the field at the time the original selection was made in 1912. In addition, it is the most prolific type so far found. One specimen of average size bore 1864 burs, as compared to 75 on *X. speciosum*. It has been found to breed true, and since it is distinguished at once by its short smooth globose bur, I am naming it tentatively ***Xanthium globosum***.

No study has yet been made of the geographical distribution and probable migrations of the several forms. The possibility suggests itself that *X. globosum* is a southern or southwestern form, developed in a region favorable to a long developmental period, and that *X. pennsylvanicum* is of more northern origin, with a correspondingly short period of growth. The two types may have met and mingled in the plains region without the possibility of a general hybridization because of the physiological isolation. An illustration of the behavior of a northern species may be cited in this connection. Seeds of *X. speciosum* Kearney obtained from South Dakota were planted about June 1, 1914, and had half grown burs by July 20, almost a full month before *X. pennsylvanicum* had developed its flowers, and six weeks before *X. globosum* was in bloom.

*X. canadense* Miller, as here interpreted, is in a number of ways intermediate between *X. globosum* and *X. pennsylvanicum*. It has an intermediate blooming period, intermediate sized burs and seeds, although the seeds stand much nearer to *X. pennsylvanicum* than to *X. globosum*, and intermediate production of anthocyanin. It has the oblong shape of *X. pennsylvanicum*, the glabrous character of the bur and the somewhat crinkly leaf of *X. globosum*. It is not yet known whether *X. canadense* can be produced by crossing *X. globosum* and *X. pennsylvanicum*, and selecting a pure form having the recombinations which it shows. While in general the



*Xanthium* population seems to be isolated according to species, there is always the possibility that the latest plants of one species may have the opportunity to cross with the earliest plants of a later blooming species. Such a cross between *X. globosum* and *X. pennsylvanicum* might possibly have given rise to *X. canadense*.

At a later time, when the range of variability of *X. globosum* has been carefully determined, the technical description of the species will be given. In the meantime the photographs will enable any one to identify the new species. There are probably a number of new species of *Xanthium* still undescribed in America, as would be indicated by the fact that half of the 8 species now recorded for the eastern half of the United States have been known less than sixteen years.

I am indebted to Mr. L. M. PEACE of the botany department of the University of Kansas for the excellent photographs of the types, and especially to Dr. J. M. GREENMAN, curator of the herbarium of the Missouri Botanical Garden, St. Louis, for examining the photographs and comparing the materials with specimens in the herbarium, and for information regarding the synonymy of *X. americanum* and *X. glabratum* with *X. canadense* Miller.

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